The changing structure of immigration to the OECD: what welfare effects on member countries?*

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Abstract

We investigate the welfare implications of two pre-crisis immigration waves (1991–2000 and 2001–2010) and of the post-crisis wave (2011–2015) for OECD native citizens. To do so, we develop a general equilibrium model that accounts for the main channels of transmission of immigration shocks – the employment and wage effects, the fiscal effect, and the market size effect – and for the interactions between them. We parameterize it for 20 selected OECD member states. We find that the three waves induce positive effects on the real income of natives, although the size of these gains varies across countries and across skill groups. Nonetheless, in relative terms, the post-crisis wave induces smaller welfare gains compared to the previous ones. This is due to the changing origin-mix of immigrants, which translates into lower levels of human capital. This overall result applies to all OECD countries and to all categories of native citizens; they are robust to various technological externalities related to schooling, birthplace diversity, and diaspora externalities.

Keywords: Immigration; Welfare; Crisis; Inequality; General Equilibrium.

JEL classifications: C68, F22, J24.

1 Introduction

For the last 50 years or so, industrialized countries have experienced a sharp rise in the proportion of immigrants originating from developing countries. The common portrayal of this process is a massive inflow of poorly educated immigrants who are trying to gain access to the labor markets and welfare systems of rich countries. This inflow is usually perceived as depressing wages, causing job losses, increasing income inequality, and widening fiscal

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deficits. Contrary to popular perceptions, the academic literature advocates relatively small economic effects of immigration; many studies have even identified global economic gains for the host-country population. Still, little is known about the evolution of these gains and about the consequences of the gradual trend in the origin-mix of immigrants. Has the economic impact of immigration deteriorated over time? Has the post-crisis immigration wave been less beneficial or more detrimental than earlier ones? Who are the winners and losers from recent immigration waves? These are the questions addressed in this paper.

More precisely, this paper investigates the welfare effect of the post-crisis immigration wave for OECD native citizens, and compares it with two pre-crisis waves. For 20 selected OECD member states, we develop a general equilibrium model that accounts for the main channels of transmission of immigration shocks. The model is parameterized to match the economic and socio-demographic characteristics of each country in the year 2010. Using data on immigration stocks by country of origin, education level, duration of stay and labor market status, we identify the size and structure of three waves of immigration, (i) immigrants who arrived between 1991 and 2000, (ii) those who arrived between 2001 and 2010, and (iii) those who arrived between 2011 and 2015 (referred to as the post-crisis wave). We then quantify how the real income of native citizens has been affected by these three immigration waves, distinguishing between working age natives and retirees, and between college graduates and the less educated.

Immigration affects the size of the economy as well as the composition and preferences of the population. Thanks to the development of new theoretical foundations and to the recent availability of comparable migration data, a growing consensus on how to formalize the economic responses to immigration shocks has emerged in the literature. In particular, recent studies have investigated how immigration impacts wages, employment rates and income inequality (e.g., Card 2009; Ottaviano and Peri 2012), taxes and public spending (e.g., Storesletten 2000), and firms' entry and exit decisions and the variety of goods available to consumers (e.g., Di Giovanni et al. 2015; Iranzo and Peri 2009). Assessing the welfare impact of immigration on natives requires accounting for these various transmission channels and for the interactions between them. This task is performed in Aubry et al. (2016), who combine the major transmission channels of migration shocks into an integrated, multi-country model with heterogeneous individuals and firms. Their model allows to quantify the effect of each channel, to identify the dominant ones, and to compare the between- and within-country redistributive effects of immigration. Although labor market and fiscal effects are non-negligible in some countries, they conclude that an important source of gain comes from the market size effect, i.e. the change in the variety of goods available to consumers translating into a change in the average price index.

In this paper, we depart from the model developed in Aubry et al. (2016). Contrary to them, we abstract from international trade in goods and services (which is shown to induce negligible, first-order effects on the welfare impact of immigration), but we account for changes in labor market participation and for unemployment rates of immigrants. There are two reasons why accounting for the labor market status of immigrants might be important. First, immigrants from poor countries are perceived as having smaller participation rates than natives and other immigrants; hence, the rising share of these migrants might reduce the average participation and employment rates. Second, economic responses to immigration are likely to be affected by the "employability" of immigrants. If employment rates are low,

immigration induces less competition on the labor market, but smaller fiscal gains and smaller market size effects. Another value added of this paper is that we assess the sensitivity of our results to less traditional mechanisms of transmission highlighted in the recent literature, such as productivity externalities related to cultural diversity (e.g., Alesina et al. 2016; Docquier et al. 2017), to schooling (Moretti 2004a,b; Iranzo and Peri 2009) or to the increased diffusion of productive capacity across countries (e.g., Kerr 2017; Bahar and Rapoport 2017).

Overall, our analysis suggests that the three immigration waves induce positive effects on the real income of natives. We find no evidence of systematic changes across the two pre-crisis immigration waves. On the contrary, the post-crisis wave induces smaller welfare gains compared to the earlier ones. This is because recent immigrants are relatively less educated than former immigrants, a phenomenon that is due to the changing origin-mix. Recent immigrants earn less and induce smaller effects on prices and income tax rates. With the exception of Portugal, this result applies to all OECD countries. We find large cross-country variations in the welfare impact of immigration, but these disparities are strongly persistent across immigration waves. More precisely, countries exhibiting the largest gains are Australia, Luxembourg, the United Kingdom, Switzerland, France and Austria. Overall, these are the countries where quality-selective immigration policies are implemented, or where population aging has reached an advanced stage. In spite of these economic gains, anti-immigration sentiments are on the rise in some of these countries. The smallest gains are obtained in Scandinavian countries, Belgium, Spain and Greece. The effect of immigration on income inequality vary across countries. Although immigration does not adversely affect the real income of less educated natives, it increases the income gap with college graduates in the majority of countries (especially in Scandinavian countries, Belgium, Spain and Greece). The inequality impact has not systematically intensified after the crisis. Again, this suggests that the decreasing gain from the post-crisis immigration applies to all categories of native citizens.

The remainder of the paper is organized as follows. Section 2 provides stylized facts on the changing size and structure of immigration as well as on the process of self-selection of migrants. Section 3 describes the theoretical model and the calibration strategy. Quantitative results are discussed in Section 4. Finally, Section 5 concludes.

2 The changing origin-mix of immigrants

Immigration has become a first-order political issue in virtually all industrialized countries. This is partly due to the fact that the size and structure of immigration have considerably evolved over the last half century. This is illustrated on Figure 1, which depicts immigration trends for 20 selected OECD countries, namely the 15 members of the European Union (EU15), the US, Canada, Australia, Switzerland and Japan. Exploiting bilateral migration data from Özden et al. (2011) and from United Nations (2014), Figure 1.a shows that the share of the foreign-born population living in high-income countries increased from 4.6 to 11.0 percent between 1960 and 2015 (+6.4 percentage points). Figure 1.b shows that on average, this change is totally explained by the inflow of immigrants from developing countries, whose share in the total population increased from 1.5 to 7.9 percent (once again, +6.4 percentage points). In spite of limited differences across countries, an increasing share of the population

of OECD member states is originating from countries that are economically, geographically and culturally more distant. In the US (red bold curve), the population share of immigrants from developing countries increased by 9.6% (1.3 times the change in the total immigration rate); in the EU15 (black bold curve), it increased by 7.1% (83% of the total change). The growth rate of the total stock of immigrants has been curbed by the recent crisis. However, the crisis has affected both inflows from rich and from poor countries; the fraction of immigrants originating from developing countries has been stable after 2010, around 85% in the US and around 67% in the EU15.

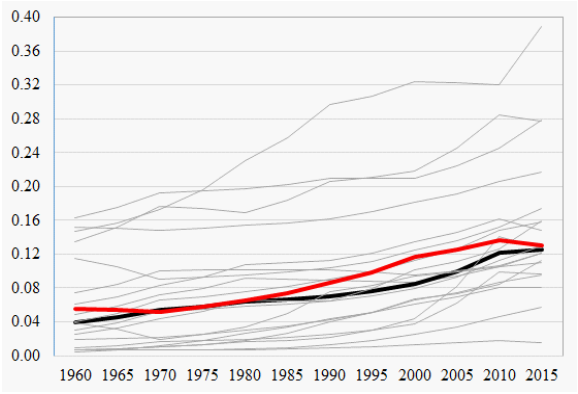
In this context, the rising concerns about immigration are legitimate. Developing countries exhibit lower productivity levels, lower levels of human capital, and lower labor market participation rates (mostly due to lower female participation rates). The changing origin-mix of immigrants is thus usually associated with a decrease in their average skill, productivity and participation rate. Figures 1.c to 1.f provides the mean gaps in schooling, income, and labor market participation between origin and destination countries, as proxied by the ratio of the (weighted) mean level observed in migrants' origin countries to the mean level observed in the destination country. A ratio above unity means that the average immigrant is originating from a country with more schooling, higher income per capita or higher participation rates; a ratio below unity means that immigrants exhibit less productive characteristics. Between 1960 and 2015, the schooling ratio decreased in the majority of countries (except in the US, Australia, Canada, Switzerland and to a lesser extent, in Japan, Belgium and Portugal). It increased from 0.27 to 0.35 in the US; it decreased from 1.12 to 0.73 in the EU15 (see Figure 1.c). Over the same period, the income ratio decreased in all countries. It declined from 0.50 to 0.26 in the US and from 0.66 to 0.46 in the EU15 (see Figure 1.d). Finally, although the males' participation ratio is small and stable over time (see Figure 1.f), the females' participation ratio declined in virtually all countries (except in the US and Japan). It increased from 0.84 to 0.88 in the US, and decreased from 1.05 to 0.91 in the EU15 (see Figure 1.e).

The view of the population is affected by the changing origin-mix of immigrants. The 2014 edition of the Transatlantic Trends on Immigration reveals that about 60 percent of European citizens view emigration and immigration as a problem and not as an opportunity. Concerns are particularly important about immigrants from developing countries; 56 percent of Europeans expressed concerns about extra-EU immigration, while only 43 percent perceive intra-EU migration as a problem. Public opinions are partly governed by non-economic reasons such as the perceived negative effects of immigration on social cohesiveness, national identity, crime, terrorism, etc. However, attitudes towards immigration are systematically correlated with two major economic concerns, the perceived adverse labor market and fiscal effects. The European Social Survey data for the year 2014 show that only 26.0 percent of European respondents believe that immigrants contribute positively to public finances, and only 35.9 percent think that immigrants create new jobs for natives.[1]

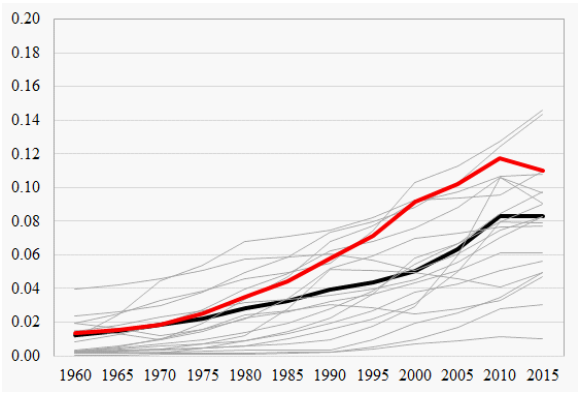
[1] See http://trends.gmfus.org/transatlantic-trends/ and http://www.europeansocialsurvey.org/.

Fig. 1 Changing size and origin-mix of immigrants
(EU15 member states and settlement countries, 1960-2015)

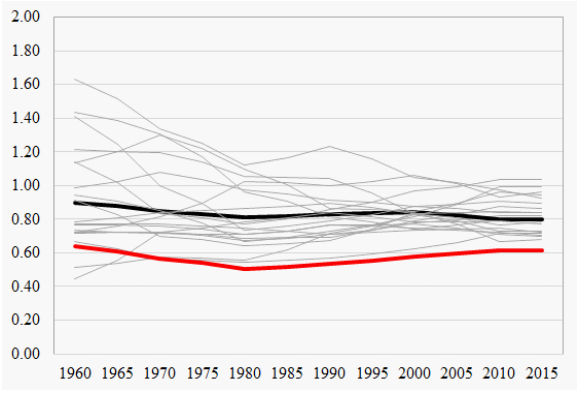
1.a. All foreign born (% pop)



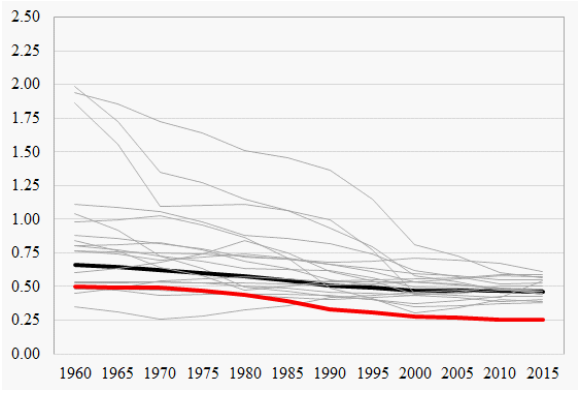
1.b. Foreign born from developing (% pop)



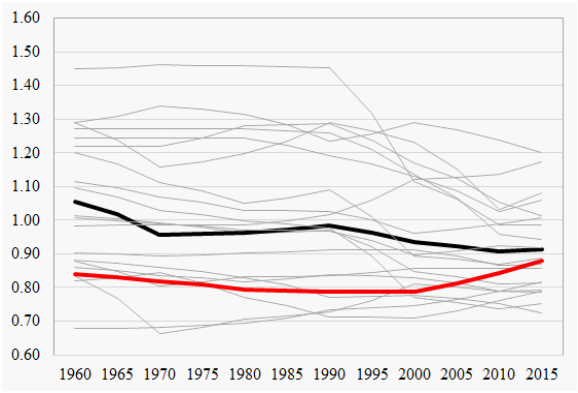
1.c. Mean years of schooling at origin (% dest)



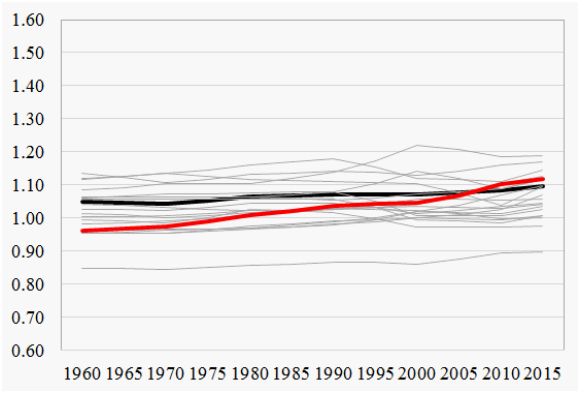
1.d. Mean inc. per capita at origin (% dest)



1.e. Mean female labor part. rate at origin (% dest)



1.f. Mean male labor part rate at origin (% dest)



Notes. Figure 1 shows the results for 20 selected countries: the 15 members states of the European Union (EU15), the US, Canada, Australia, Switzerland and Japan. The bold black curve represents the average of the EU15; the bold red curve represents the US; light grey curves represent the other countries. Data in 10-year intervals from 1960 to 2010 are obtained from (Özden et al., 2011); data for 1995, 2005, 2010 and 2015 are obtained from UNPOP; data for 1965, 1975, 1985 interpolate decadal observations.

The general perceptions about immigrants' characteristics must be tempered by the fact that migrants self-select on many attributes (Abramitzky et al. 2012; Chiquiar and Hanson 2005; McKenzie and Rapoport 2010; Fernández-Huertas Moraga 2011; Ambrosini and Peri 2012; Kaestner and Malamud 2013). The degree of self-selection governs migrants' characteristics and outcomes at destination. If it is strong, the correlation between migrants' and home-country attributes is low. Furthermore, if migrants select their destination country to limit the gap between their own preferences and the host-country characteristics, a positive correlation between migrants' and host-country attributes can be obtained.

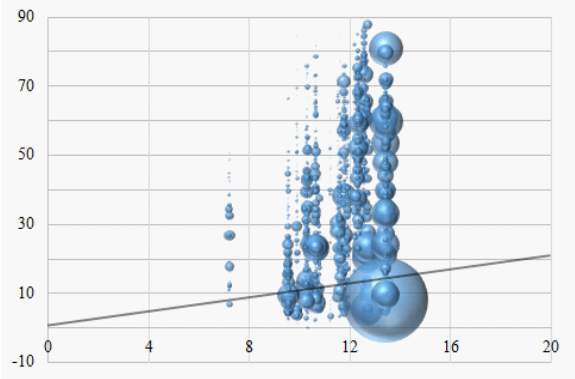
To illustrate the process of self-selection, we use the Database on Immigrants in OECD countries (DIOC) described in Arslan et al. (2015). The data are collected by country of destination and are mainly based on population censuses or administrative registers. The DIOC database provides detailed information on the country of origin, demographic characteristics, level of education, and labor market outcomes of the population of OECD member states. For the sake of comparability, the data from Özden et al. (2011) and from United Nations (2014) identify the total stock of immigrants in all destination countries, but only provide data by country of origin. Focusing on the census round 2010, we extract information about the country of origin (220 countries), age (25-64 and 65+), educational attainment (college graduates and less educated) and labor market status (employed, unemployed, inactive) of immigrants residing in the 20 selected destination countries listed above. For the 4,400 dyads of countries in the sample, Figure 2 compares the average level of education and participation rate of immigrants aged 25 and over with those of the host- and home-country.

The comparison with the host-country characteristics is illustrated on Figure 2.a and 2.b. Figure 2.a shows that the correlation between the bilateral and host-country shares of college-educated is small. The coefficient of correlation equals 0.18 and is independent on the corridor size. On Figure 2.b, the correlation in participation rates is larger (0.28); it amounts to 0.44 and 0.34 when considering the largest 50 and 100 corridors (representing 50 and 62% of the total migrant stock), respectively. In sum, the levels of schooling of immigrants and host populations are almost orthogonal, while immigrants' participation rates are affected by the host-country characteristics, a sign of self-selection or assimilation.

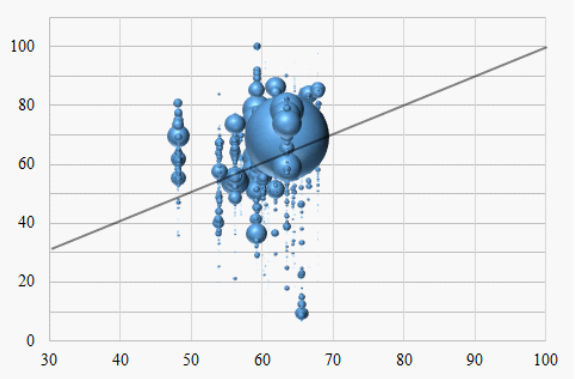
The comparison with the home-country characteristics is illustrated on Figure 2.c to 2.f. Figure 2.c shows that the correlation between the bilateral and home-country shares of college-educated is small, albeit non negligible. It is equal to 0.3 in the full sample of 4,400 dyads. Ranking countries by corridor size (from the 30 largest to the smallest), Figure 2.e reveals that the correlation is even slightly smaller for the largest corridors (0.23 for the largest 30 countries). On the contrary, Figures 2.d and 2.f show that the correlation between bilateral and host-country participation rates is greater for large corridors. In the full sample, this correlation is almost nil (0.05). However, it amounts to 0.55 for the 30 to 40 largest corridors (representing 40 and 45% of the total migrant stock) and to 0.37 when considering the 50 largest corridors. Again, the levels of schooling of immigrants and those left-behind are poorly correlated (a strong sign of self-selection), while migrants' participation rates remain correlated with the home-country characteristics when considering the largest corridors, a sign of lower selection or imperfect assimilation. Our model accounts for dyadic disparities in participation rates.

Fig. 2 Migrants' selection by education and by labor market participation, 2010

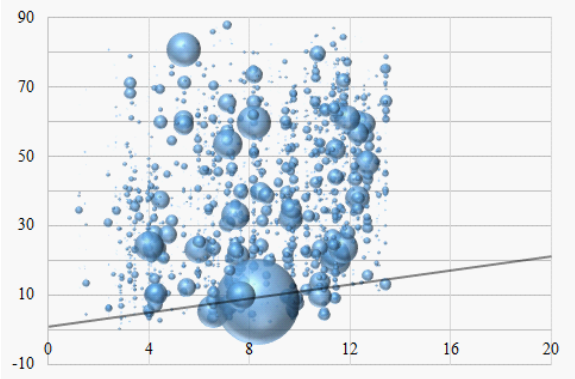
2.a. College grads (%): bilateral vs destination (B-D)



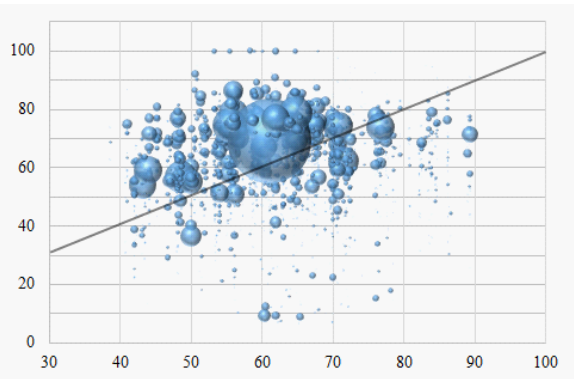
2.b. Participation (%): bilateral vs destination (B-D)



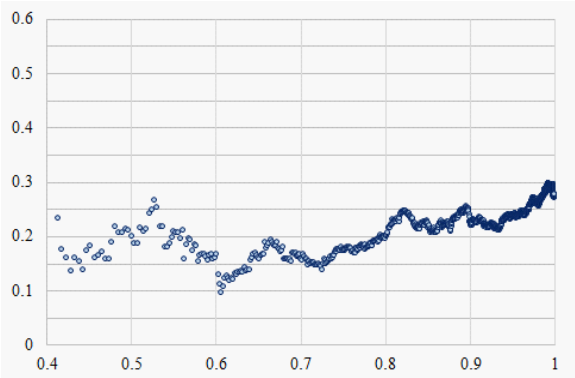
2.c. College grads (%): bilateral vs origin (B-O)



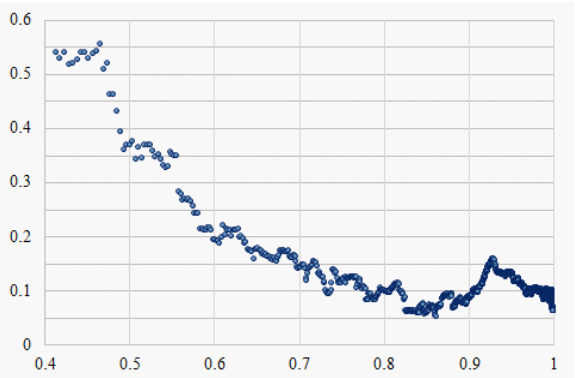
2.d. Participation (%): bilateral vs origin (B-O)



2.e. College grads (%): B-O correlation and size



2.f. Participation (%): B-O correlation and size



Notes. Figure 2.a shows the correlation between the shares of college graduates among host-country residents (X-axis) and bilateral migrants (Y-axis); Figure 2.b shows the correlation in participation rates. Figure 2.c shows the correlation between the shares of college graduates among origin-country residents (X-axis) and bilateral migrants (Y-axis); Figure 2.d shows the correlation in participation rates. On Figure 2.e and 2.f, dyads are ranked by descending order with respect to the migrant stock. Starting from the 30 largest stocks, we add the next largest dyad and compare the share of the total migrant stock involved (X-axis) with the correlation between origin-country and bilateral shares of college graduates (Y-axis on Fig 2.e) and participation rates (Y-axis on Fig 2.f) . Data are obtained from the DIOC database for the year 2010.

3 Theoretical model

We develop a static model endogenizing the economic effect of immigration on macroeconomic variables and on the welfare of native (non-migrant) citizens. We formalize countries as independent entities, and do not account for trade linkages or capital flows between them;[2] the country subscript is omitted for simplifying notations. Each country is populated by heterogeneous individuals, heterogeneous goods, and the government. As far as individuals are concerned, we distinguish *between natives and immigrants* – o refers to the origin country; $o = n$ for natives, and $o = (f_1, f_2, ..., f_F)$ for immigrants from the F foreign countries, *between age groups* – $a = (y, r)$ for working-age individuals and retirees, and *between two skill groups* – $s = (h, l)$ for college graduates and the less educated. The demographic size of these groups is denoted by $N^o_{a,s}$. As far as firms are concerned, there is a mass B of firms that operate on a monopolistically competitive market with a fixed cost of entry, each of them produces a differentiated good. The government taxes income and consumption to finance redistributive transfers, unemployment benefits and public consumption.

Four channels of transmission of immigration shocks are taken into consideration in the benchmark model: the employment effect, the wage effect, the fiscal effect, and the market size effect. Additional channels are investigated in the robustness analysis. We model the labor market effects as in Ottaviano and Peri (2012), the fiscal effect as in Storesletten (2000), the market-size effect as in Krugman (1980). In addition, we account for the difference in employment rates between immigrants and natives by introducing heterogeneity in the disutility of labor and in unemployment rates. The data reveal that differences in employment rates are mainly governed by differences in participation rates. This motivates our choice to endogenize participation rates and to assume that active workers spend an exogenous fraction of their active time in unemployment (due, for example, to exogenous job destruction and finding rates).

In this section, we describe the preferences and the technology used to endogenize individuals' and firms' decisions in Sections 3.1 and 3.2. We then characterize the monopolistically competitive equilibrium in Section 3.4. Finally, we explain our parameterization strategy in Section 3.5.

3.1 Individuals

The preferences of a representative individual of age a, education level s and origin country o are described by the following utility function:

$$\mathcal{U}^o_{a,s} = C^o_{a,s} - \frac{\phi^o_{a,s}(1-\gamma^o_{a,s})^{1+\eta}}{1+\eta}. \tag{1}$$

The utility is a linear function of a composite consumption aggregate, $C^o_{a,s}$ (discussed below) and depends negatively on the amount of time spent on the labour market, $1-\gamma^o_{a,s}$. Hence, the supply of labor in the group (o, a, s) is defined as $(1-\gamma^o_{a,s})N^o_{a,s}$. The parameter η is the

[2] Using a similar framework, Aubry et al. (2016) find that the welfare effect is strongly robust to the inclusion of trade. Ortega and Peri (2009) find that capital adjustments are rapid in open economies: an inflow of immigrants increases one-for-one employment and capital stocks in the short term (i.e. within one year), leaving the capital/labor ratio unchanged.

inverse of the elasticity of labor supply to labor income; it is common to all individuals. The parameter $\phi^o_{a,s}$ captures the disutility of participating in the labor market (i.e. disutility of working or of searching for a job). It varies by age group, by education level and by country of origin. We assume $\phi^o_{r,s} = \infty$ for all retirees, implying that retirees are inactive and only consume the transfers received from the government. As far as working age individuals are concerned, we calibrate $\phi^o_{y,s}$ so as to match the observed participation rate in the group. Hence, the model allows to capture differences in participation rate across skill groups and across natives and immigrants from a specific origin country; these differences can be due to heterogeneity in cultural traits or social norms.

In addition, we assume that consumers have a preference for variety. This means that the utility from consumption does not only depend on the quantity of goods consumed; it also increases with the variety of goods. Remember there is a mass B of varieties available for consumption. Following Krugman (1980), the utility of consumption is described by a CES utility function over the continuum of varieties:

$$C^o_{a,s} = \left[\int_0^B c^o_{a,s}(i)^{\frac{\epsilon-1}{\epsilon}} di\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{2}$$

where $c^o_{a,s}(i)$ stands for the quantity of variety $i \in B$ produced in the country and consumed by an individual of type (a, o, s). Varieties are imperfect substitutes, characterized by a constant elasticity of substitution equal to $\epsilon > 1$.

In each destination country, working age immigrants in a given skill group are perfectly substitutable workers from the firm's perspective. They have identical marginal productivity levels and earn identical wages per hour worked, $w^f_s \ \forall o = (f_1, f_2, ..., f_F)$, which usually differs from the native's wage rate, w^n_s. At each moment in time, active workers face exogenous job separation and finding rates, implying that they spend an exogenous fraction $(1 - u^o_s)$ of their active time in employment, and the remaining fraction u^o_s in unemployment (searching for a job). Working and searching induce the same disutility. Job separation and finding rates differ across natives and immigrants, but are homogenous among immigrants (i.e., u^f_s $\forall o = (f_1, f_2, ..., f_F)$ and u^n_s for natives). During each unemployment spell, active workers receive unemployment benefits, b^o_s, that are assumed to be proportional to their wage rate. We write $b^o_s = \delta w^o_s$ where δ captures the replacement rate of the national unemployment insurance scheme. Finally, the government allocates group-specific transfers to each group of individuals, $T^o_{a,s}$, that do not depend on the labor market status. In practice, $T^o_{a,s}$ includes redistributive transfers that vary across origin and skill types, as well as public consumption which is assumed to be identical across all individuals (including retirees). Labor income is taxed at a flat rate τ, while consumption is taxed at a flat rate v.

The individual budget constraint writes as following:

$$\begin{aligned} \int_0^B c^o_{a,s}(i)(1+v)p(i)di &= (1-\gamma^o_{a,s})\left[(1-u^o_s)w^o_s(1-\tau) + u^o_s b^o_s\right] + T^o_{a,s}, \\ (1+v)PC^o_{a,s} &= (1-\gamma^o_{a,s})\varpi^o_s + T^o_{a,s}, \end{aligned} \tag{3}$$

where $p(i)$ measures the price of variety i, P stands for the ideal price index (capturing the average price per unit of the optimal consumption bundle), and $\varpi^o_{a,s}$ measures the nominal

income per active hour, i.e. per hour supplied on the labor market (a weighted average of net wages and unemployment benefits: $\varpi_s^o \equiv w_s^o\left[(1-u_s^o)(1-\tau)+u_s^o\delta\right]$).

The individual's optimization problem consists in maximizing (1) subject to (2) and (3). The solution of this problem writes as following:

$$1-\gamma_{a,s}^o = \left(\frac{\varpi_s^o}{\phi_{a,s}^o(1+v)P}\right)^{1/\eta}, \tag{4}$$

$$C_{a,s}^o = \phi_{a,s}^o\left(\frac{\varpi_s^o}{\phi_{a,s}^o(1+v)P}\right)^{\frac{1+\eta}{\eta}}+\frac{T_{a,s}^o}{(1+v)P}, \tag{5}$$

$$\mathcal{U}_{a,s}^o = \frac{\eta C_{a,s}^o}{1+\eta}+\frac{T_{a,s}^o}{(1+\eta)(1+v)P}. \tag{6}$$

Clearly, the labor market participation rate increases with the real income per active hour, ϖ_s^o/P, and decreases with the disutility of labor, $\phi_{a,s}^o$; $1/\eta$ is the elasticity of labor supply to real income per active hour. If $\delta < 1-\tau$, expected unemployment spells reduce the expected income of active individuals ($\partial\varpi_s^o/\partial u_s^o < 0$), implying that the participation rate is a decreasing function of the expected unemployment rate. As firms use the same technology and preferences over varieties are symmetric, firms adopt the same pricing rule ($p(i)=p\ \forall i$) and the ideal price index equals $P=p(i)B^{1/(1-\epsilon)}$. Given $\epsilon>1$, this implies that an increase in the number of varieties available to consumers reduces the ideal price index, due to increased competition between monopolistic manufacturers.

The mapping between bilateral and destination notations is straightforward. In equilibrium, the supply of labor of college-educated and less educated natives is defined as:

$$\begin{aligned} H^n &\equiv (1-u_h^n)N_{y,h}^n(1-\gamma_{y,h}^n), \\ L^n &\equiv (1-u_l^n)N_{y,l}^n(1-\gamma_{y,l}^n). \end{aligned}$$

Symmetrically, the supply of labor of college-educated and less educated immigrants is defined as:

$$\begin{aligned} H^f &\equiv \sum\nolimits_{o=f_1}^{f_F}(1-u_h^f)N_{y,h}^o(1-\gamma_{y,h}^o), \\ L^f &\equiv \sum\nolimits_{o=f_1}^{f_F}(1-u_l^f)N_{y,l}^o(1-\gamma_{y,l}^o). \end{aligned}$$

3.2 Firms

There is a continuum of firms with a measure B producing differentiated consumption goods indexed by i. Each monopolistic manufacturer i is characterized by the same technology, adopts the same pricing rule, employs the same number of employees, offers the same wage rates to its employees, and produces the same quantity of goods, $y(i)$. Hence, the total GDP in the economy amounts to $Y=By(i)$.

At the firm level, the production technology is described by a nested constant elasticity of substitution (CES) function. The upper-level production function writes as:

$$y(i)=Aq(i)=A\left[\theta_1 h(i)^{(\sigma_1-1)/\sigma_1}+(1-\theta_1)\ell(i)^{(\sigma_1-1)/\sigma_1}\right]^{\sigma_1/(\sigma_1-1)}, \tag{7}$$

where the scale factor A stands for total factor productivity (TFP), and $q(i)$ is the quantity of efficiency units labor used by firm i. Labor in efficiency unit $q(i)$ is a CES function of $h(i)$ and $\ell(i)$, which stand for the composite quantity of college-educated and less educated employees; σ_1 measures the elasticity of substitution between skill groups; and θ_1 determines the relative productivity of college graduates compared to the less educated.

To capture the imperfect substitution between immigrants and natives (as in Card 2009; Ottaviano and Peri 2012; Docquier et al. 2014), we assume that $h(i)$ and $\ell(i)$ are governed by a lower-level, nested CES production technology:

$$h(i) = \left[\theta_2 h^n(i)^{(\sigma_2-1)/\sigma_2} + (1-\theta_2)h^f(i)^{(\sigma_2-1)/\sigma_2}\right]^{\sigma_2/(\sigma_2-1)}, \tag{8}$$

$$\ell(i) = \left[\theta_2 \ell^n(i)^{(\sigma_2-1)/\sigma_2} + (1-\theta_2)\ell^f(i)^{(\sigma_2-1)/\sigma_2}\right]^{\sigma_2/(\sigma_2-1)}, \tag{9}$$

where σ_2 measures the elasticity of substitution between immigrant and native workers within each skill group, and θ_2 determines the relative productivity of native workers compared to immigrants. As stated above, immigrants from all origin countries are treated as perfect substitutes from the employer's perspective.

Firms maximize their profits. Given their market power, their optimal price is equal to a constant mark-up over the marginal cost of employing one unit of efficient labour: $p = \frac{\epsilon}{\epsilon-1}\frac{\overline{w}}{A}$, where $\overline{w}$ is a wage composite related to the nested CES production function (the price of one efficiency unit of labor):

$$\begin{aligned}
\overline{w} &= \left[\theta_1^{\sigma_1}\overline{w}_h^{1-\sigma_1} + (1-\theta_1)^{\sigma_1}\overline{w}_l^{1-\sigma_1}\right]^{1/(1-\sigma_1)} \\
\overline{w}_s &= \left[\theta_2^{\sigma_2}(w_s^n)^{1-\sigma_2} + (1-\theta_2)^{\sigma_2}(w_s^f)^{1-\sigma_2}\right]^{1/(1-\sigma_2)} \quad \text{for } s=(h,l).
\end{aligned}$$

And the optimal employment levels, $h^o(i)$ and $\ell^o(i)$, are such that the marginal value of employee equals the nominal wage rate for each type of workers. These optimal employment levels $\left\{h^n(i), \ell^n(i), h^f(i), \ell^f(i)\right\}$ solve the following system:

$$w_h^n = \left(\frac{q(i)}{h^n(i)}\right)^{1/\sigma_2}\left(\frac{\theta_1\overline{w}}{\overline{w}_h}\right)^{\sigma_1/\sigma_2}\theta_2\overline{w}_h, \tag{10a}$$

$$w_l^n = \left(\frac{q(i)}{\ell^n(i)}\right)^{1/\sigma_2}\left(\frac{(1-\theta_1)\overline{w}}{\overline{w}_l}\right)^{\sigma_1/\sigma_2}\theta_2\overline{w}_l, \tag{10b}$$

$$w_l^f = \left(\frac{q(i)}{\ell^f(i)}\right)^{1/\sigma_2}\left(\frac{(1-\theta_1)\overline{w}}{\overline{w}_l}\right)^{\sigma_1/\sigma_2}(1-\theta_2)\overline{w}_l, \tag{10c}$$

$$w_f^h = \left(\frac{q(i)}{h^f(i)}\right)^{1/\sigma_2}\left(\frac{\theta_1\overline{w}}{\overline{w}_h}\right)^{\sigma_1/\sigma_2}(1-\theta_2)\overline{w}_h. \tag{10d}$$

Profits are decreasing with the number of firms: $\frac{1}{\epsilon}\left(\frac{p}{P}\right)^{1-\epsilon}\overline{w}Q = \frac{\overline{w}Q}{B\epsilon}$, where Q is the aggregate quantity of efficiency units of labor available in the economy, $Q = Bq(i)$; Q is given by the nested CES combination of the four types of workers employed in the economy. However, each firm faces a fixed entry cost, ψ, to enter the domestic market. This fixed costs is expressed in units of efficient labor composite, and is interpreted interpreted as an investment that a firm must make to explore the market and differentiate its product.

Therefore, the aggregated demand for labor also includes the demand for workers employed for investment purposes. In a free entry equilibrium, operational profits are zeroed by the entry of new firms ($\frac{\overline{w}Q}{B\epsilon} - \psi\overline{w} = 0$), so that there is no incentive to start the production process by new entrants. In line with Krugman (1980), the zero-profit condition defines B, the equilibrium mass of manufacturers operating in the economy:

$$B = \frac{Q}{\epsilon\psi}. \tag{11}$$

3.3 Government

The fiscal policy consists of two tax rates – the consumption tax rate v and and a labor income tax rate τ, a vector $T^o_{a,s}$ of group-specific transfers that includes redistributive transfers and public consumption, and the unemployment insurance scheme allocating a fraction δ of the wage rate to each unemployed active individual. Our fiscal bloc is a static version of Storesletten (2000), except that we do not link transfers to wages and we rule out budget deficits. Hence, the government budget constraint writes as:

$$(v+\tau)Y = \delta \sum_{o,a,s} N^o_{a,s}(1-\gamma^o_{a,s})u^o_s w^o_s + \sum_{o,a,s} N^o_{a,s} T^o_{a,s}. \tag{12}$$

On the revenue side, total production is equal to total consumption; consumption and income tax revenues are proportional to Y. The mix between the consumption and income tax rates only induces redistributive effects: a greater income tax rates means greater transfers from working age individuals to retirees. On the expenditure side, unemployment benefits are proportional to the foregone labor income of unemployed active individuals, while transfers and public consumption are exogenous. Transfers differ across natives and immigrants but not across immigrants from different origin countries (i.e., $T^f_{a,s}$ $\forall o = (f_1, f_2, ..., f_F)$ and $T^n_{a,s}$ for natives). We assume that the income tax rate τ adjusts to balance the government budget.

3.4 Monopolistic competitive equilibrium

Definition 1 *For a set of common parameters $\{\epsilon, \eta, \sigma_1, \sigma_2\}$, a set of destination-specific parameters $\left\{u^0_s, \theta_1, \theta_2, A, \psi, \delta, T^n_{a,s}, T^f_{a,s}/T^n_{a,s}, v\right\}$, and a set of origin-destination specific parameters $\left\{\phi^o_{a,s}, N^o_{a,s}\right\}$, the monopolistically competitive equilibrium is a set of endogenous variables $\left\{w^o_s, c^o_{a,s}, \gamma^o_{a,s}, \ell^n, h^n, \ell^f, h^f, y, p, P, B, \tau\right\}$ that satisfies the following conditions: (i) individuals maximize their utility (1) subject to (2) and (3), (ii) optimal employment (10) and zero-profit condition (11) holds, (iii) labor markets clear (i.e., $H^o = Bh^o(i)$ and $L^o = B\ell^o(i)$ for all o) and (iv) the government budget (12) is balanced.*

3.5 Parameterization

Our model is parameterized to match the economic and socio-demographic characteristics of 20 OECD member states (EU15 countries, the US, Australia, Canada, Japan and Switzerland) in the year 2010. This implies matching the population structure (by age, by education, by origin), income per capita and income disparities between groups of workers, labor markets

outcomes, and fiscal data. This section describes the data sources used for parameterizing the model, and discusses the calibration strategy. Table 1 summarizes the calibration outcomes.

Population and labor force data ($N^o_{a,s}$) - In line with Section 2, we use the Database on Immigrants in OECD countries (DIOC) described in Arslan et al. (2015). For each OECD member state, the database covers the census round 2010 and documents the structure of the population by country of origin, by age, by education level, by duration of stay, and by labor market status. We first classify individuals by country of origin (220 countries). Immigrants reporting ex-USSR, ex-Yugoslavia or ex-Czechoslovakia as their origin country are assumed to originate from Russia, Serbia and the Czech Republic, respectively. Immigrants who did not report their origin country are distributed proportionately to observations. Then, we define the college-educated group as individuals who have at least one year of college education or a bachelor degree (ISCED code = 5). Those with no education and with pre-primary, primary or secondary education completed are defined as the less educated. We classify individuals who did not report their education level as low-skilled. As for the age structure, we defined individuals aged 25 to 64 as the working aged group; those aged 65 and over form the retiree population. Individuals who did not report their age are assumed to belong to the working age group.

Labor force data ($\gamma^o_{a,s}, u^o_s$) - An important feature of the DIOC database is that it includes data on the labor market status. For each origin country and each skill group, we identify the proportions of inactive, active-employed, and active-unemployed individuals aged 25 to 64. Individuals who did not report their labor market status are distributed across groups proportionately to observations. We can thus identify the number of employed, unemployed and inactive individuals for each skill group and for each country of origin.

Income data (Y, w^o_s) - In the model, labor is the only factor of production. Hence, the national income is equal to the national gross domestic product (GDP). Aggregate income data are taken from *OECD.Stat* database; we use the level of GDP in PPP value. By definition, total income is the sum of wages earned by native and immigrant workers. Data on the wage ratio between college-educated and less educated workers are taken from the *Education at Glance 2012* report of the OECD; we use them as a proxy for $\overline{w}_h/\overline{w}_l$. Data on the wage ratio between native and immigrant workers are obtained from Büchel et al. (2008) and from Docquier et al. (2014); we use them as a proxy for w^n_s/w^f_s. Using these wage ratios, employment levels and GDP data, we can proxy the wage rate and labor income of each group.

Fiscal data ($v, \tau, T^n_{a,s}$) - Comparable aggregate data on public finances are obtained from the *Annual National Accounts* harmonized by the OECD. This database reports aggregate public revenues and public expenditures by broad category, as percentage of GDP. We use to identify the consumption tax rate (v) as well as the ratio of public expenditure to GDP, which is equal to $v + \tau$ in our model. We also identify the amount of public consumption and treat it as a homogenous transfers to all residents (as a part of $T^o_{a,s}$). Redistributive transfers are also included in $T^o_{a,s}$. In line with Aubry et al. (2016), we use the Social Expenditure Database (SOCX) of the OECD to decompose social protection expenditures, and the European Union Statistics on Income and Living Conditions (EU-SILC, provided by Eurostat) to disaggregate education and social protection transfers received by the natives;

we identify transfers to natives by education level and by age group. We add these transfers to public consumption per capita and use it as a proxy for $T^n_{a,s}$. Finally, we also collect data on the share of unemployment benefits in GDP.

Calibration of common parameters ($\epsilon, \sigma_1, \sigma_2, \eta$) - The model includes four common parameters that are calibrated in line with the existing literature; benchmark values are reported in the top panel of Table 1. The elasticity of substitution between varieties of goods is estimated in the range of 3 to 8.4 by Feenstra (1994). We assume $\epsilon = 7$ as a benchmark value, which means that the model predicts conservative market size effects. As far as elasticities of substitution between groups of worker are concerned (σ_1 and σ_2), we follow Ottaviano and Peri (2012) and use $\sigma_1 = 2$ and $\sigma_2 = 20$. Finally, we use $\eta = 10$, which implies an elasticity of labor supply to income of 0.1, as in Evers et al. (2008). We consider alternative levels in the robustness analysis (see Section 4.3).

Table 1. Common and country-specific parameters

Parameters	Description	Mean	s.d.	Source / Moment matched
Parameters without country variation				
ϵ	Elast. subst. btw goods	7.0	n.a.	Feenstra (1994)
σ_1	Elast. subst. btw skills	2.0	n.a.	Ottaviano and Peri (2012)
σ_2	Elast. subst. immig/natives	20	n.a.	Ottaviano and Peri (2012)
$1/\eta$	Elast of labor supply	0.1	n.a.	Evers et al. (2008)
Parameters varying across countries				
$\phi^o_{a,s}$	Disutility of labor (relative to US)	1.675	1.487	Matches $\gamma^o_{a,s}$
u^o_s	Unemployment rates	0.095	0.072	Matches DIOC data
θ_1	Firms' preference HS	0.557	0.050	Matches $\overline{w}_h/\overline{w}_l$
θ_2	Firms' preference native	0.527	0.040	Matches w^n_s/w^f_s
A	TFP (relative to US)	0.894	0.294	Matches total GDP
ψ	Cost of entry (relative to US)	1.435	0.952	Nb. days to create a firm
δ	Replacement rate	0.600	0.300	Matches Un. Exp/GDP
$T^n_{a,s}$	Public transfers (% of GDPpc)	0.321	0.089	Matches Gov. Exp/GDP
$T^f_{a,s}/T^n_{a,s}$	Public transfer (ratio)	1.066	0.467	Matches fiscal cont. immig
v	Consumption tax rate	0.173	0.042	Matches OECD data

Country-specific parameters - The model also includes other parameters that vary across countries to match some moments, as summarized in the bottom panel of Table 1. Preferences differ across types of individual. The parameter governing the disutility of labor, $\phi^o_{a,s}$, is allowed to vary by dyad of country and by skill group. Using (4), it is calibrated to match the observed participation rate, $1-\gamma^o_{a,s}$. We obtain a matrix of 220×20 parameters. The average level is 67% greater than the disutility parameter of American non-migrants. Exogenous unemployment rates directly are available from the DIOC data (with a mean of 9.5%).

Technological parameters are also allowed to vary across countries. The firms' preferences for workers are calibrated to match the wage ratios between workers. Hence, θ_1 is set to match data on $\overline{w}_h/\overline{w}_l$, while θ_2 matches data on w^n_s/w^f_s. The mean levels of θ_1 and θ_2 exceed 0.5. This determines the aggregate quantity of labor in efficiency unit. The TFP level, A, is then

chosen to match the observed level of GDP in PPP value. The mean level of A is 10.5% smaller than the US level. As for the fixed cost of entry, ψ, we equalize it with the number of days required to set up a business, available from the *OECD.Stat* database, normalized by the US level. The scale of this variable has no impact on our results. The mean level is 43.5% greater than the US level.

As far as fiscal parameters are concerned, we calibrate the replacement rate δ to match the observed share of unemployment benefits in GDP. Regarding the other public transfers, we assume that their age and skill profiles are identical across immigrants and natives. The SOCX and SILC data allow us to identify the transfer profile for natives. We jointly rescale the transfers to natives $T^n_{a,s}$ and calibrate the immigrant-to-native ratio of public transfers, $T^f_{a,s}/T^n_{a,s}$, to match two moments: the observed share of public expenditures in GDP, and the estimated fiscal contribution of immigrants as percentage of GDP. On average, $T^n_{a,s}$ amounts to 32.1% of income per capita, and immigrants receive 6.6% more than natives with similar characteristics. Cross-country estimations of the fiscal impact of immigration are taken from OECD (2013, Tab 3.7). The consumption tax rates is extracted from the OECD *Annual National Accounts* database. Hence, by definition, the equilibrium income tax rate τ can be computed from (12) and matches the share of public expenditures in GDP.

4 Results

Focusing on 20 selected OECD countries, our goal is to quantify the impact of three recent immigration waves on the welfare of the native population, and to characterize the role of the changing structure of immigration flows. Starting from the calibrated model for the year 2010, we simulate three immigration counterfactuals: in the first one, we eliminate from the stock of immigrants in 2010 those who arrived between 2001 and 2010; in the second one, we eliminate those who arrived between 1991 and 2000 and who were still living in the destination country in 2010; in the third one, we add the new immigrants who arrived between 2011 and 2015 (forming the post-crisis wave).

Due to return migration, mortality and changing incentives to migrate, the 1991-2000 counterfactual differs in size from the 2001-2010 one. Similarly, the 2011-2015 shock is smaller as it only covers a period of 5 years following the last economic crisis. These shocks induce varying effects on the proportion of immigrants in the total population, Δm, where $m \equiv \sum_{o=f_1}^{f_F} N^o_{a,s}/(\sum_{o=f_1}^{f_F} N^o_{a,s} + N^n_{a,s})$. To identify the effect of the changing structure of immigration, we express the macroeconomic and welfare responses in relative terms by dividing all effects by Δm; we thus report semi-elasticities of macroeconomic variables and welfare to immigration. For each type of native individual, the semi-elasticity of welfare to immigration writes as:

$$\frac{\Delta \mathcal{U}^n_{a,s}/\mathcal{U}^n_{a,s}}{\Delta m} = \frac{\left(\mathcal{U}^n_{a,s}\right)_{With\ Mig} - \left(\mathcal{U}^n_{a,s}\right)_{Without\ Mig}}{\Delta m \left(\mathcal{U}^n_{a,s}\right)_{Without\ Mig}}. \tag{13}$$

The relative change in utility is expressed as percentage of deviation from the no-migration counterfactual (i.e. after eliminating the 1991-2000 or 2001-2010 pre-crisis waves in the first two experiments, or before adding the 2011-2015 post-crisis wave in the third experiment).

Hence, a positive deviation implies a welfare gain due to the immigration wave, while a negative deviation implies a welfare loss. The same expression is used when discussing the effect on any extensive macroeconomic variable (expressed in USD). When describing the effect on intensive variables (i.e., a variable which does depend on the volume of the system, such as the tax rate, the (un)employment rate, the proportion of college graduates, the support ratio, etc.), we simply divide the numerator of the expression above by Δm.

The model accounts for four mechanisms of transmission, namely two labor market effects (through participation rates and wages), the fiscal effects, and market size effect. These four effects and the interactions between them govern the welfare impact on working age natives. As for native retirees, they are only affected by the market size channel (i.e., by the price response to immigration). In this section, we first describe the three immigration waves in Section (4.1). We then discuss the benchmark results in Section (4.2). Section (4.3) provides a sensitivity analysis of our results, focusing on the 2000-10 immigration wave only.

4.1 Immigration waves

We describe the effects of the counterfactuals on socio-demographic variables, i.e. on the population size, on the proportion of college graduates in the working age population, $h \equiv \sum_o N^o_{y,h} / \sum_{o,s} N^o_{y,s}$, and on the support ratio (defined as the ratio of working age residents to population: $s \equiv \sum_{o,s} N^o_{y,s} / \sum_{o,a,s} N^o_{a,s}$. The first counterfactual consists of eliminating immigrants who arrived between 2001 and 2010. Data on immigrants by duration of stay, by origin country and by education level are available from the DIOC database. The same database can be used to characterize the second counterfactual, which consists in eliminating immigrants who arrived between 1991 and 2000. As for the third counterfactual, we use the United Nations data and compute the growth rates of total immigrant stocks by country of origin between 2010 and 2015. We apply these growth rates to the stock of working age immigrants in 2010, and assume additional immigrants have the same education level as (bilateral) migrants arrived between 2001 and 2010. Hence, in the third experiment, the effect of immigration on human capital is totally governed by the changing origin-mix of the migrant inflows after the crisis. We assume that all adult immigrants from these three waves belong to the working age population.

Figure 3 characterizes the socio-demographic effects of these three immigration waves. The left panel (Fig 3.a, 3.c and 3.e) compares the effect of the 1991-2000 wave on the horizontal axis with that of the 2001-2010 wave on the vertical axis. The right panel (Fig 3.b, 3.d and 3.f) compares the effect of the 2001-2010 wave on the horizontal axis with that of the 2011-2015 wave on the vertical axis. The 45-degree line allows visualizing which wave dominates.

Figures 3.a and 3.b depict the size of the shocks (Δm). Comparing 1991-2000 with 2001-2010, the average shock sizes equal 3.7 and 5.1 percentage points, respectively. The 2001-2010 wave is larger in 11 countries, including France, Belgium, the United Kingdom, Australia and Sweden. Changes are drastic in Ireland and Luxembourg. On the contrary, the 1991-2000 waves dominates in 8 countries, including Switzerland, Germany, Austria and, to a lesser extent, Canada and the United States. Comparing 2001-2010 with 2011-2015, the average shock sizes equal 5.1 and 1.6 percentage points, respectively (the latter corresponds to a 3.2

p.p. shock over a decade). Overall, Figure 3.b shows that the pre- and post-crisis trends are very similar; this means that most observations are close to the 22.5-degree line (i.e., the 5-year shock of 2011-2015 is slightly smaller than half the 10-year shock of 2001-2010). Exceptions are Belgium and Luxembourg, where the post-crisis migration inflows are larger, and Ireland, where they are smaller. Remember that in Eq. (13), we neutralize the size of the shock (Δm) when interpreting its welfare implications, in order to highlight the role of the changing structure of immigration.

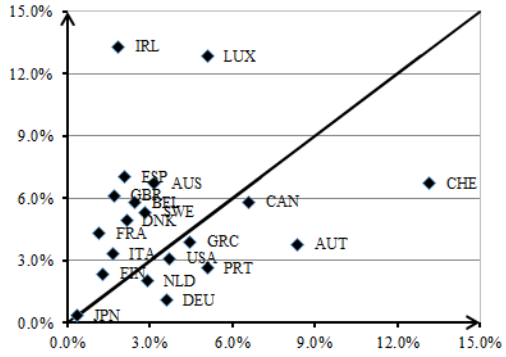
Figures 3.c and 3.d depict the effect on the proportion of college graduates ($\Delta h/\Delta m$). Changes in human capital govern the productivity and inequality responses to migration. The two figures show *a remarkable persistence across immigration waves*. Countries where immigration increases human capital include Australia, Canada and the United Kingdom (i.e., countries conducting quality-selective immigration policies) as well as Luxembourg. On the contrary, immigration reduces human capital in Scandinavian, Belgium or Greece. Between 2001 and 2010, immigration increases human capital in Switzerland and decreases it in Portugal. Figure 3.d shows that most observations are located below the 45° line, implying that, with very few exceptions, *the post-crisis immigration wave is relatively less educated than the previous one*.

Figures 3.e and 3.f depict the effect on the support ratio ($\Delta s/\Delta m$). Changes in the age structure govern the fiscal responses to migration. By definition, the semi-elasticity is equal to the ratio of retirees in the native population and is independent of the size and structure of immigration. Hence, the effect of immigration is greater in countries with older populations (such as Germany, Luxembourg, Austria, Italy or Sweden), and smaller in countries with younger populations (such as Canada, United States, Australia, Ireland). Hence, *immigration increases the support ratio everywhere, and particularly in countries where the median age of the native population is large*.

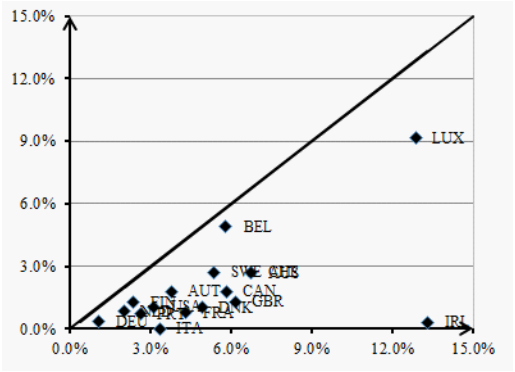
Fig. 3 Socio-demographic effects of three immigration waves

(Δm and semi-elasticity to Δm)

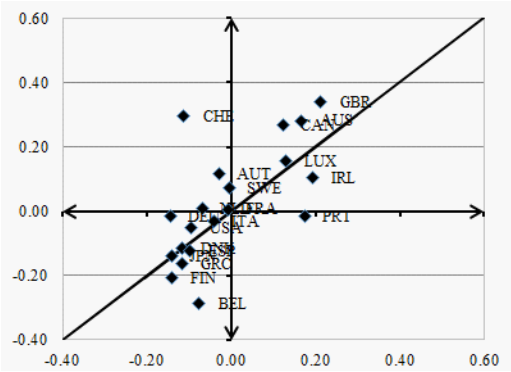
3.a. Proportion of Foreigners (Δm)
1991-2000 (X-axis) vs 2001-2010 (Y-axis)



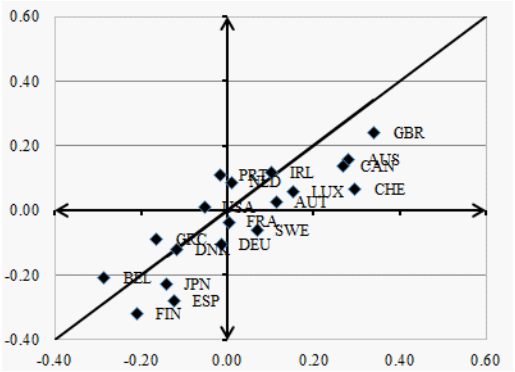
3.b. Proportion of Foreigners (Δm)
2001-2010 (X-axis) vs 2011-2015 (Y-axis)



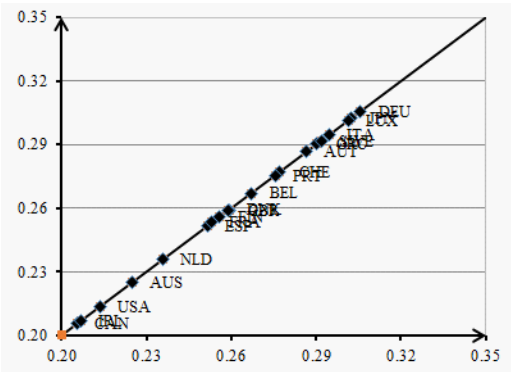
3.c. Proportion of college graduates (Δh/Δm)
1991-2000 (X-axis) vs 2001-2010 (Y-axis)



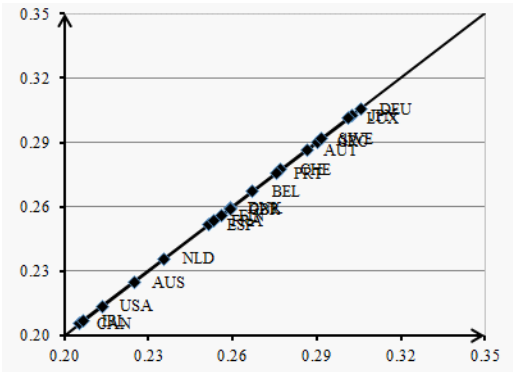
3.d. Proportion of college graduates (Δh/Δm)
2001-2010 (X-axis) vs 2011-2015 (Y-axis)



3.e. Support ratio (Δs/Δm)
1991-2000 (X-axis) vs 2001-2010 (Y-axis)



3.f. Support ratio (Δs/Δm)
2001-2010 (X-axis) vs 2011-2015 (Y-axis)



Notes. Figure 3 shows the results for 20 selected countries: the 15 members states of the European Union (EU15), the US, Canada, Australia, Switzerland and Japan. The left panel compares the effects of the 1991-2000 and 2001-2010 immigration waves. The right panel compares the effects of the 2011-2015 and 2001-2010 immigration waves. The bold diagonal is the 45 degree line.

4.2 Benchmark results

Figure 4 characterizes the macroeconomic effects of the three immigration waves. We focus on the average employment rate, the income tax rate and the average price index. As before, the left panel (Fig 4.a, 4.c and 4.e) compares the effect of the 1991-2000 wave with that of the 2001-2010 wave. The right panel (Fig 4.b, 4.d and 4.f) compares the effect of the 2001-2010 wave with that of the 2011-2015 wave.

Figures 4.a and 4.b depict the employment response to immigration. On average, the 1991-2000 and 2001-2010 waves reduce the economy-wide employment rate by 0.25 and 0.30 percentage point, respectively. The 2011-2015 wave induces very similar effects: it reduces the employment rate by 0.15 percentage point, implying a 0.30 point drop over a 10-year period. As far as cross-country disparities are concerned, these figures show a strong persistence over immigration waves. Immigration reduces employment rates in countries where immigrants are relatively less educated (such as Scandinavian countries and Belgium). In the other countries, the effect is small. The correlation between the employment and human capital responses to immigration is limited (around 0.5). Hence, employment responses are very persistent across immigration waves: the *degradation of immigrant's human capital after the crisis has small effects on the employment response to immigration*, as evidence from Figure 4.b.

The fiscal impact of immigration is described on Figures 4.c and 4.d. The fiscal effect is positive in all countries and across all immigration waves, which is due to the fact that working age immigrants always have a positive contribution to public finances. Although immigrants receives greater transfers than natives with similar characteristics, recent immigration flows made the population younger. On average, increasing the immigration share by one percentage point reduces the income tax rate by 0.8 percentage point in 1991-2000, by 1.0 percentage point in 2001-2010, and by 0.3 percentage point in 2011-2015 (implying a 0.6 p.p. effect over a 10-year period). Again, the degradation of the human capital response to immigration between 2011 and 2015 induces smaller fiscal gains for natives. The fiscal impact is strongly persistent across waves; its size is governed by the fiscal policy and by the age structure of the population. Countries exhibiting large fiscal gains are France, Switzerland and Austria (countries where population aging has reached an advanced stage or where immigrants receive relatively smaller transfers). Countries where fiscal gains are consistently smaller are Canada, Germany, the United States (countries where the population is younger or where immigrants receive relatively greater transfers).

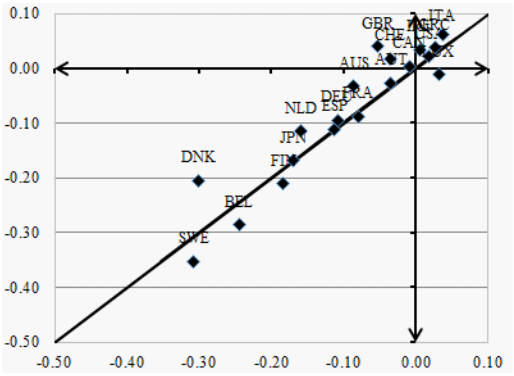
Figure 4.e and 4.f illustrate the market size effect of immigration. Using a conservative elasticity of substitution between goods ($\epsilon = 7$), we obtain non negligible effects on the average price index. On average, increasing the immigration share by one percentage point reduces the average price level by 1.0% in 1991-2000, by 1.4% in 2001-2010, and by 0.4% in 2011-2015 (implying a 0.8% effect over a 10-year period). The price elasticity to migration depends on changes in human capital and employment rates. Again, these figures show *a strong persistence over immigration waves*. Countries where market size effects are large are Australia, Canada, Luxembourg, Ireland. The effect is smaller in Scandinavian countries and Belgium. Remember the market size mechanism is the only channel through which native retirees are economically affected by immigration (due to the fixed-benefit fiscal rule). Figure 4.e and 4.f thus depict the impact of immigration on the real income of retirees; this effect is positive in all countries and across all waves.

Fig. 4 Macroeconomic effects of three immigration waves

(Semi-elasticity to Δm)

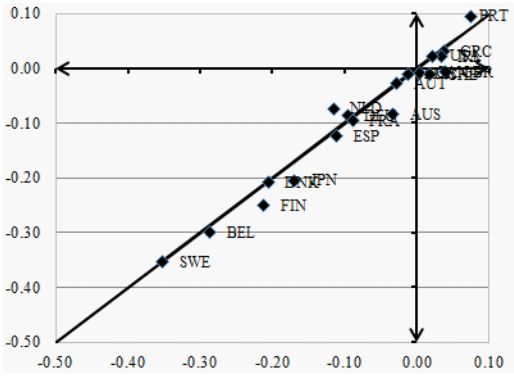
4.a. Employment rates (Δe/Δm)

1991-2000 (X-axis) vs 2001-2010 (Y-axis)



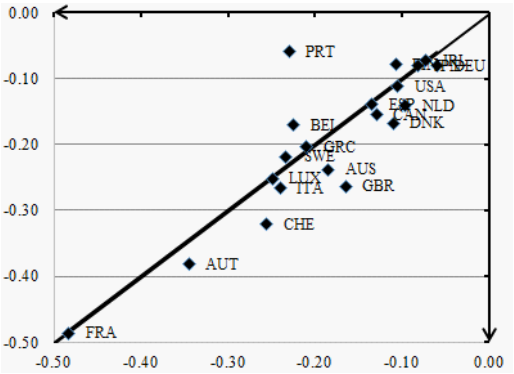
4.b. Employment rates (Δe/Δm)

2001-2010 (X-axis) vs 2011-2015 (Y-axis)



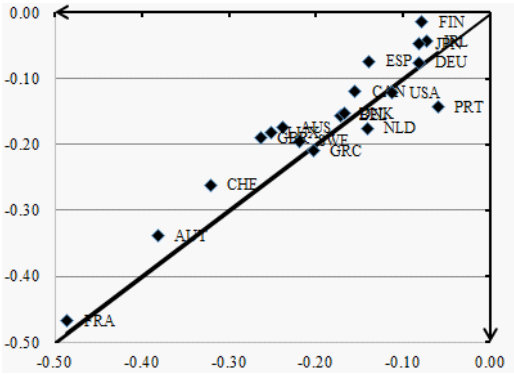
4.c. Income tax rate ($\Delta\tau$/Δm)

1991-2000 (X-axis) vs 2001-2010 (Y-axis)



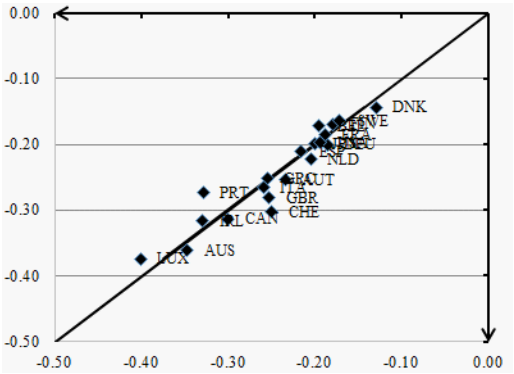
4.d. Income tax rate ($\Delta\tau$/Δm)

2001-2010 (X-axis) vs 2011-2015 (Y-axis)



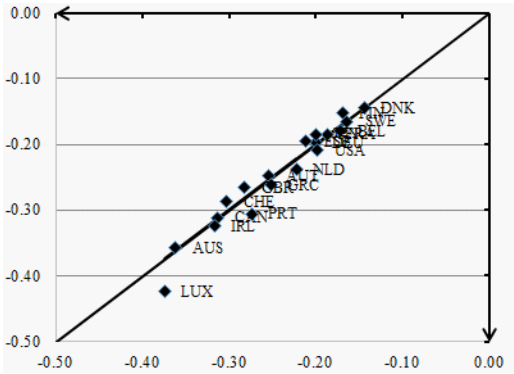
4.e. Price index (ΔP/P/Δm)

1991-2000 (X-axis) vs 2001-2010 (Y-axis)



4.f. Price index (ΔP/P/Δm)

2001-2010 (X-axis) vs 2011-2015 (Y-axis)



Notes. Figure 4 shows the results for 20 selected countries: the 15 members states of the European Union (EU15), the US, Canada, Australia, Switzerland and Japan. The left panel compares the effects of the 1991-2000 and 2001-2010 immigration waves. The right panel compares the effects of the 2011-2015 and 2001-2010 immigration waves. The bold diagonal is the 45 degree line.

We now aggregate the transmission channels and compute the welfare implications of immigration for the natives. The utility level is computed in (6); given $\eta = 10$ in the benchmark, $\mathcal{U}^o_{a,s}$ is almost proportional to the real income level, $C^o_{a,s}$. Figure 5 gives the effect on the average real income of working age natives (net labor income plus transfers, divided by the average price index), and the effect on the real income ratio between young college-educated natives and the less educated. The left panel (Fig 5.a and 5.c) compares the effect of the 1991-2000 wave on the horizontal axis with that of the 2001-2010 wave on the vertical axis. The right panel (Fig 5.b and 5.d) compares the effect of the 2001-2010 wave on the horizontal axis with that of the 2011-2015 wave on the vertical axis.

Figure 5.a and 5.b show that immigration always increase the real income of working age natives. In addition, cross-country disparities in *the average welfare gain are strongly persistent across immigration waves.* The largest immigration gains are obtained in Australia, Austria, France, Luxembourg, Switzerland and the United Kingdom. The smallest gains are observed in Scandinavian countries, Germany, Belgium, Spain and the United States. The latter set of countries exhibit smaller fiscal and market size gains from immigration. The 2001-2010 immigration wave induces very similar effects as the 1991-2000 one, although the gain increased for Swiss and British natives, and decreased for the Portuguese. On the contrary, Figure 5.b shows that the post-crisis wave is relatively less beneficial in all countries, with the exception of Portugal. Consistently with Figure 4, this can be explained by the changing origin-mix of immigrants, which affects the level of human capital, income tax rates and market size.

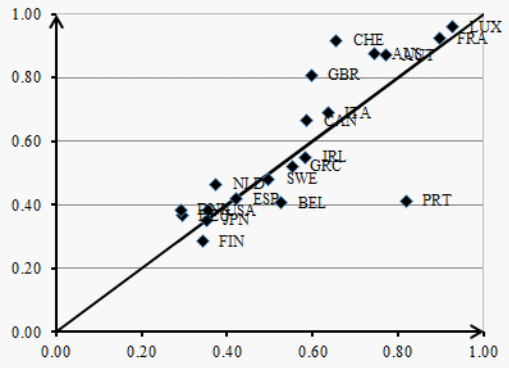
Figure 5.c and 5.d depict the effect on inequality in real income, as defined by the ratio of real income between college-educated and less educated natives aged 25 to 64. Although we identify a high degree of persistence in cross-country disparities, persistence is smaller than for macroeconomic variables and average effects. Large variations across waves are observed in Portugal and Switzerland. We find no evidence of a systematic change in inequality after the crisis. Overall, it comes out that all immigration waves increase inequality in the majority of countries. This is particularly the case in Scandinavian countries, Belgium, Spain, Greece. The effect is small in countries such as France, Austria or the United States. Immigration decreases inequality in countries where migrants are positively selected such as Luxembourg, Australia, Canada and the United Kingdom. This being said, the impact on the real income of low-skilled natives is almost always positive, as the fiscal and market size effects dominate labor market effects. The only exceptions are Spain, Japan and Greece after the 2011-2015 wave, where the semi-elasticity of income to migration is negative but virtually nil (the loss is smaller than 0.1%).

Overall, the key findings of our analysis are that (i) the last three waves of immigration have not deteriorated the real income of the native population, (ii) that the distribution of the gains vary across countries and across skill groups as a function of the structure of immigration, (iii) that these redistributive effects are strongly persistent over time, and (iv) that the post-crisis immigration waves is less beneficial for natives than the previous ones.

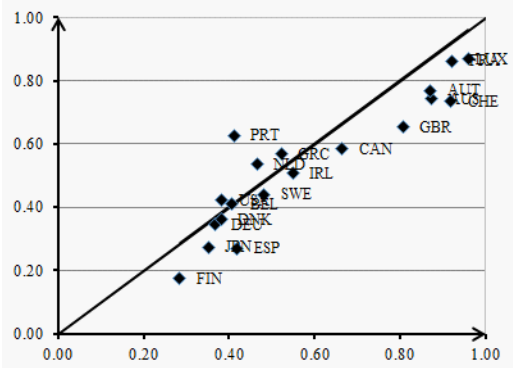
Fig. 5 Welfare impact of three immigration waves

(Semi-elasticity to Δm)

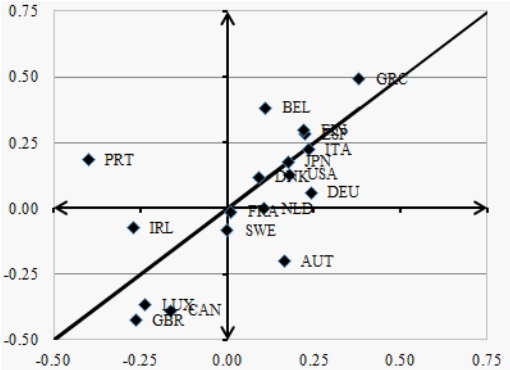
5.a. Average real income of working-age natives 1991-2000 (X-axis) vs 2001-2010 (Y-axis)



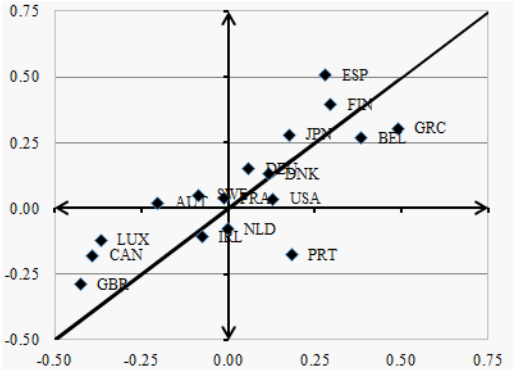
5.b. Average real income of working-age natives 2001-2010 (X-axis) vs 2011-2015 (Y-axis)



5.c. HS-to-LS ratio of real income 1991-2000 (X-axis) vs 2001-2010 (Y-axis)



5.d. HS-to-LS ratio of real income 2001-2010 (X-axis) vs 2011-2015 (Y-axis)



Notes. Figure 4 shows the results for 20 selected countries: the 15 members states of the European Union (EU15), the US, Canada, Australia, Switzerland and Japan. The left panel compares the effects of the 1991-2000 and 2001-2010 immigration waves. The right panel compares the effects of the 2011-2015 and 2001-2010 immigration waves. The bold diagonal is the 45 degree line.

4.3 Robustness checks

In this section, we investigate whether the conclusions of the benchmark analysis are robust to the choice of parameters, to the inclusion of technological externalities, and to the characteristics of immigrants. Focusing on the effect of the 2001-2010 wave, we assess the sensitivity of its impact on the average level of real income and on income inequality. Figure 6 depicts the results obtained under nine variants of the benchmark model.

Sensitivity to elasticities. On Figures 6.a and 6.b, we consider alternative levels for three elasticities, namely for the elasticity of substitution between goods in the utility function ($\epsilon = 4$ instead of 7), for the elasticity of substitution between immigrant and native workers in production ($\sigma_2 = 50$ instead of 20), and for the inverse of the elasticity of labor supply to labor income ($\eta = 5$ instead of 10). For these three variants, we recalibrate the TFP (A) and

the disutility of labor (ϕ) to match observed GDP levels and participation rates in 2010, and simulate the no-migration counterfactual.

Figure 6.a shows that the average welfare impact of immigration is one and a half times greater when the elasticity of substitution between goods equals 5, and 1.2 times greater when labor market participation rates are more elastic to labor income. Increasing the elasticity of substitution between immigrant and native workers to 50 has a minor impact on our results. In all variants, the correlation with the benchmark results exceeds 0.99. As far as the inequality impact is concerned, results are almost independent on the choice of elasticity (see Figure 6.b). Hence, the welfare effects depicted on Figure 5 are highly robust to the choice of elasticities.

Sensitivity to externalities. On Figures 6.c and 6.d, we account for three TFP externalities. The first one is a schooling externality; it assumes that the elasticity of TFP to the proportion of college graduates in the labor force is equal to 0.3, in line with de la Croix and Docquier (2012) or Aubry et al. (2015). The second one is a diversity externality; it assumes that the semi-elasticity of TFP to birthplace diversity is equal to 0.2, as in Alesina et al. (2016). The third one is a diaspora externality which capture the effect of migration on trade and FDI, and the resulting effect of trade and FDI on TFP. A first strand of literature has identified a causal impact of migration on trade and FDI, with respective elasticities of 0.1 and 0.2.[3] Another strand has identified a causal effect of trade and FDI on TFP, with respective elasticities of 0.3 and 0.01 (see Larch, 2016; Feyrer, 2009). Combining these findings gives an elasticity of TFP to migration of 0.035. For these three variants, we calibrate the scale factors of the TFP function to match the GDP levels in 2010, and simulate the no-migration counterfactual.

Figure 6.c shows that the schooling externality significantly increases the gain from immigration in countries attracting college-educated migrants (such as Australia, Luxembourg, the United Kingdom and Switzerland) while it reduces the gain in Spain, Belgium and Greece. Birthplace diversity quantitatively matters only in newer immigration countries such as Ireland, Portugal and Finland. At the estimated elasticity levels, the diaspora externality has negligible effects on the results. Results for inequality are almost independent on the inclusion of externalities (see Figure 6.d). Again, the welfare effects depicted on Figure 5 are highly robust to TFP externalities.

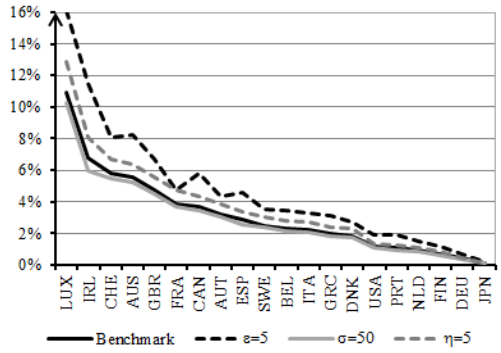
Sensitivity to immigrants' characteristics. On Figures 6.e and 6.f, we consider three alternative distributions of characteristics of immigrant workers. We first assume that all immigrants have the same disutility of labor as natives (same ϕ's). We then assume they have identical unemployment rate as natives (same u's). Finally, we assume identical skill structures for the immigrant and native populations (same h's). For these three variants, we simulate the new hypothetical benchmark for 2010 (keeping other parameters constant), and simulate the no-migration counterfactuals.

[3] On migration and trade, see for example Iranzo and Peri (2009), Felbermayr et al. (2010), Felbermayr and Toubal (2012) and, for studies exploiting natural experiments, Parsons and Vezina (2017) and Steingress (2015). On migration and FDI, see Kugler and Rapoport (2007) and Javorcik et al. (2010).

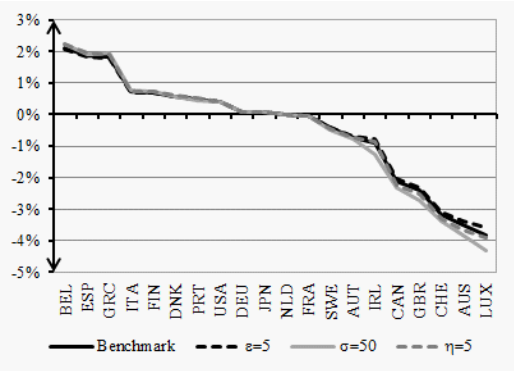
Fig. 6 Sensitivity analysis (immigration wave 2000-2010)

(Semi-elasticity to Δm)

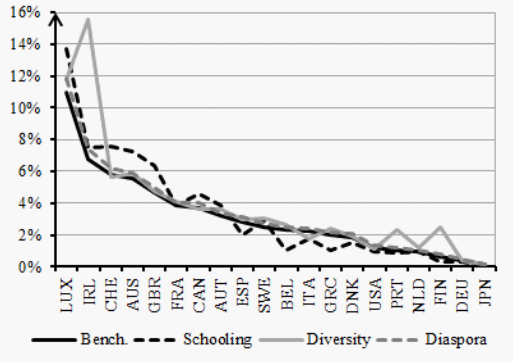
6.a. Average real income of working-age natives
Sensitivity to elasticities



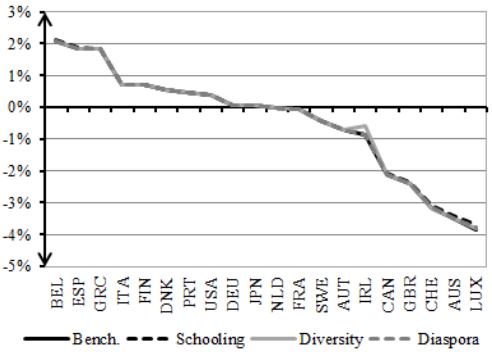
6.b. HS-to-LS ratio of real income
Sensitivity to elasticities



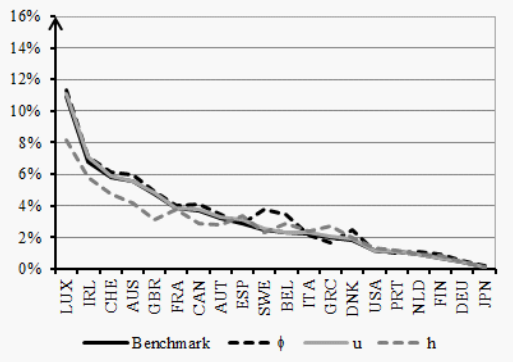
6.c. Average real income of working-age natives
Sensitivity to externalities



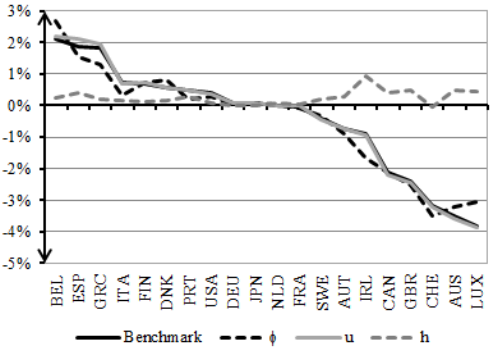
6.d. HS-to-LS ratio of real income
Sensitivity to externalities



6.e. Average real income of working-age natives
Sensitivity to migrants' characteristics



6.f. HS-to-LS ratio of real income
Sensitivity to migrants' characteristics



Notes. Figure 4 shows the results for 20 selected countries: the 15 members states of the European Union (EU15), the US, Canada, Australia, Switzerland and Japan. The left panel compares the effects of the 2000-2010 and 1990-2000 immigration waves. The right panel compares the effects of the 2000-2010 and 2010-2015 immigration waves. The semi-elasticity is defined as the ratio of the percentage of deviation in X to the change in the immigration rate.

Figure 6.e shows that the average welfare gain from immigration is highly robust to labor market characteristics of immigrants. Imposing the same disutility of labor (governing participation rates) or the same unemployment rate as native workers marginally affects the results, with the exception of Scandinavian countries and Belgium. Inequality responses are also robust to labor market characteristics. This is in line with the fact that changes in employment rates in the post-crisis period hardly affected the welfare impact of immigration. On the contrary, equalizing immigrants' and natives' levels of schooling reduces the gains from immigration in "selective" countries (Figure 6.e), and neutralizes the inequality responses to immigration (Figure 6.f). This confirms that the level of human capital of immigrants affects the macroeconomic and welfare responses to immigration; the degradation of immigrant's human capital after the crisis is responsible for smaller welfare gains.

5 Concluding remarks

Despite large changes in the number and in the origin-mix of immigrants, little is known about the evolution of their welfare impact on the native populations in the OECD member states. This paper compares the welfare implications of two pre-crisis immigration waves (1991–2000 and 2001–2010) and of the post-crisis wave (2011–2015). Our analysis relies on a general equilibrium model that accounts for the main channels of transmission of immigration shocks – the employment and wage effects, the fiscal effect, and the market size effect – and for the interactions between them. Focusing on 20 selected OECD member states, we find that the three waves induce positive effects on the real income of natives, although the size of these gains varies across countries and across skill groups. The average welfare gain and inequality effects are strongly persistent across immigration waves. However, in relative terms, the post-crisis wave induces smaller welfare gains compared to the previous ones. This is due to the changing origin-mix of immigrants, which translates into lower levels of human capital. This overall result applies to all OECD countries and to all categories of native citizens.

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